

## Portable Field Mapping Systems Expedite Response Time After Landslides

**RESULTS:** *The Caltrans GeoResearch Group has completed a technology transfer project to demonstrate the effectiveness of portable, real-time, field mapping systems for emergency landslide field reconnaissance work. These field mapping systems combine state-of-the-art Global Positioning Systems (GPS) hardware with innovative Geographic Information Systems (GIS) and real-time mapping software. Two field mapping units were configured and test-deployed by Caltrans geotechnical staff over the past year. The units were found to be very effective for rapid development of topographic maps, cross-sections, and descriptions of landslides for engineering analyses and reports.*

### Why We Pursued This Research

Caltrans expends approximately \$10 million annually in managing landslide hazards adjacent to the State highway system. With an estimated 1200 miles of landslide prone highway corridors throughout California, approximately 200 landslides and 10 road closures occur per year and require clean up and/or mitigation. As an extreme example, in the Winter of 1997, the Mill Creek Landslide, closed State Route 50, east of Sacramento, for more than a month and dammed the American River for several hours. However, it's the smaller landslides, such as the one in Colusa County on Highway 20 shown in Figure 1, that routinely occur and require more resources.



Figure 1 – Cut slope failure on Hwy-20

Mapping landslides is an essential step in the process of understanding slope failures and designing effective repairs. Maps are used to define cross-sections, which are then used in slope stability analysis programs to design effective mitigation solutions.

In many cases, however, slides occur without warning. Caltrans geotechnical staff are often tasked with rapidly responding to these incidences, developing mitigation strategies within hours to days of the event to direct

construction and maintenance crews on how to carry out the repair work in a safe manner to restore traffic service. Although rigorous surveys are often needed in these situations, they are seldom performed due to time constraints.

### What We Did

In an effort to introduce innovative mapping technologies to the Department, a project was initiated in which two field mapping systems were acquired. The first system was based upon differential GPS (DGPS) and laser ranging hardware, providing sub-meter accuracy. The second system was based upon Real-Time-Kinematic GPS (RTK-GPS) hardware, providing centimeter level accuracy. Each system had unique advantages with regards to accuracy, user-interaction, and cost.

In a typical field mapping system the operator has a backpack or beltpack that holds the GPS unit and a ruggedized personal computer. The interface with the computer is through a handheld pen-screen, similar to a LCD screen of a laptop PC. The GPS antenna (backpack mounted or pole mounted) provides the operator's position, while a handheld or pole-mounted laser device allows the operator to stand in one position and acquire the relative coordinates of surrounding points of interest. A typical field mapping system is shown in Figure 2.

*“They have been a great help in field mapping landslide, storm damage, and rockfall sites. One person can be so much more productive by creating usable maps overnight.”*

*- Caltrans Engineering Geologist*



Figure 2 – Field mapping in progress

As points are being acquired, a topographic map is generated by the software in real-time on the computer's display as shown in Figure 3. From this data the user can generate cross-sections such as shown in Figure 4. Other data can be incorporated into maps such as field notes, digital photos, hand sketches, etc. Data from this tool can then be used for real-time landslide mapping, slope stability analysis, earthwork calculations, etc.

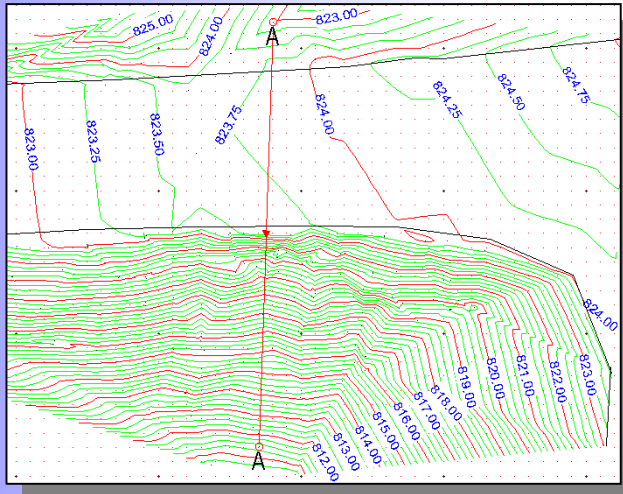


Figure 3 – Real-time topographic map generation

The systems integrator, Condor Earth Technologies, provided two training sessions on the use of the *PenMap* software and associated equipment to a group of Caltrans staff. These staff, in turn, provided training and guidance to other Caltrans users interested in deploying the equipment. A short field procedure guide was also developed specifically for Caltrans landslide mapping applications.

The two *PenMap* systems were made available for check-out to staff in Geotechnical Services over an evaluation period of approximately one year. An online reservation and checkout system was implemented to facilitate the test deployment of the two systems on a statewide basis.

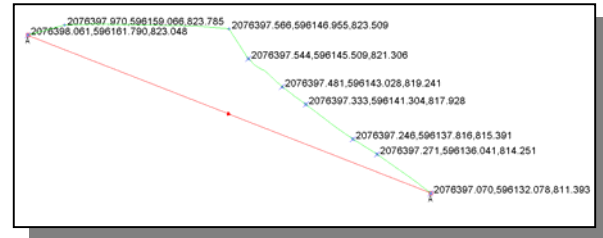


Figure 4 – Cross section of landslide

### The Researchers Recommend

This project demonstrated the effectiveness of portable field mapping systems through successful test deployments on rapid response landslide projects. Use of these types of systems can significantly reduce the time required for geotechnical staff to deliver engineering solutions for maintenance and construction work, thereby minimizing impacts to traffic.

The GeoResearch Group recommends continued use of the two field mapping systems for rapid landslide response applications. It is anticipated that the benefits realized from the time savings, the higher quality map products, and improved designs will keep these units in high demand. Additional units of this type would need to be acquired by the geotech offices for more efficient deployment statewide.

### For More Information About This Research

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